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## Feasibility

# of Using a 50- by 30- Centimeter Cell Box for Exporting McIntosh and Golden Delicious Apples

Marketing Research Report No. 847

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# Feasibility of Using a 50- by 30-Centimeter Cell Box for Exporting McIntosh and Golden Delicious Apples

By EARL D. MALLISON,<sup>1</sup> formerly *agricultural marketing specialist*,  
and DONALD R. STOKES, *agricultural marketing specialist*,  
*Transportation and Facilities Research Division, Agricultural Research Service*

## Summary

Fiberboard cell-type shipping containers, 50 by 30 cm. in length and width, were tested for shipping McIntosh and Golden Delicious apples to Europe. The 50- by 30-cm. box is one of the shipping containers recommended by the Organization for Economic Cooperation and Development (OECD) for use in the international trade of fresh fruits and vegetables. Two cell-type fiberboard boxes most commonly used by New England McIntosh apple packers were selected as control boxes for measuring the feasibility of using the 50- by 30-cm. box for McIntosh apples. The cell-type box most commonly used by Washington State Golden Delicious apple growers was used as a control box for measuring the feasibility of using the 50- by 30-cm. box for Golden Delicious apples.

Packaging materials costs, direct labor costs, and transport charges from point of origin to New York City and on to the United Kingdom would be \$0.11 more per box in the 50- by 30-cm. container than it cost in 1966 to pack and ship them in a cell-type box used by a prominent exporter of McIntosh apples and \$0.22 more than in another box commonly used by New England McIntosh packers. The 50- by 30-cm. box is slightly smaller than the two boxes currently used. Hence, if ocean freight

rates were adjusted to reflect the difference in outer dimensions, the cost for the 50- by 30-cm. box would be \$0.10 less than that for the commonly used full telescope regular-slotted box (FTRSC) and \$0.09 more than that for the full telescope half-slotted box (FTHSC).

For Washington State Golden Delicious apples, the 50- by 30-cm. box would cost \$0.27 more per box than the presently used cell box, but if ocean freight rates were adjusted to reflect the smaller size of the 50- by 30-cm box the additional cost of using it would be \$0.14 per box.

The feasibility of using a smaller box holding only three layers of apples, or roughly equivalent to the 15 kilogram weight (33 pounds) preferred by the Europeans, also was tested. Use of this size box would increase the cost of packing and shipping apples \$0.45 per 38-pound box for McIntosh apples and \$0.48 per 44-pound box for Golden Delicious apples over the cost to pack and ship them in four-layer 50- by 30-cm. boxes at 1966 freight rates.

There were no significant differences in bruising of the apples during transit from point of origin to New York City whether they were packed and shipped in the three- or four-layer 50- by 30-cm. boxes or in the cell boxes presently used for McIntosh and Golden Delicious apples.

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<sup>1</sup> Retired.

## Introduction

A committee representing the member countries<sup>2</sup> of The Organization for Economic Cooperation and Development (OECD) is developing standard containers for fruits and vegetables moving in international trade. The committee adopted the following outside dimensions for boxes:<sup>3</sup>

Dimensions adopted as final—60 cm. by 40 cm. (23.6 by 15.75 in.); 50 cm. by 30 cm. (19.7 by 11.8 in.); 40 cm. by 30 cm. (15.75 by 11.8 in.). Adopted “experimentally”—50 cm. by 40 cm. (19.7 by 15.75 in.). Adopted “temporarily”—56 cm. by 36 cm. (22.0 by 14.2 in.); 57 cm. by 38 cm. (22.4 by 15.0 in.); 44 cm. by 30 cm. (17.3 by 11.8 in.). Tolerance: minus 1 cm. (0.3937 in.).

The Committee also adopted standard dimensions for pallets as follows:

120 cm. by 100 cm. (47.24 by 39.37 in.)  
and 120 cm. by 80 cm. (47.24 by 31.4 in.)

The boxes adopted as standard use 90 percent or more of the surface, without overhang, of the standard pallets.

If the use of such containers becomes mandatory, shippers in the United States would have to export apples in these standard containers rather than in those now in use.

The purpose of this study was to ascertain the feasibility of packing and transporting to United Kingdom ports United States McIntosh and Golden Delicious apples, sized in accordance with present commercial practices, in 50- by 30-cm. cell-type boxes.

Apples were selected for this study since they have been exported in large volume for many years to European markets. A box having outside dimensions of 50 cm. (19.7 in.) long by 30 cm. (11.8 in.) wide was selected since this one, of all the OECD boxes, comes closest in size to the boxes commonly used in the United States for apples. Height varied with count size of the apple.

## Description and Capacity of Boxes

### Description

A different size of box for each count size of apple is generally used for cell-packed apples in the United States. The dimensions (length by width by depth) of the individual cells also vary with the variety of apple. The Golden Delicious apple is elongated and the McIntosh apple is round and is flattened at both the stem and calyx end. These conditions make it difficult to standardize the cell-pack boxes with the limited number of base dimensions adopted by the OECD.

The cell boxes used in test shipments are shown in figure 1. Dimensions of the boxes used

for McIntosh apples are given in table 1, and those for Golden Delicious apples are given in table 2.

Control A and B boxes are most commonly used in New England for McIntosh apples and control C box is most commonly used in Washington for Golden Delicious apples.

All the 50- by 30-cm. and control boxes were made from 200-pound-test double-faced corrugated fiberboard. The joints were glued.

Cell partitions commercially used for McIntosh apples are made from 0.040 chipboard, and those used for Golden Delicious apples are made from 200-pound-test double-faced corrugated fiberboard. Chipboard partitions were used in the control and 50- by 30-cm. boxes for McIntosh apples. For Golden Delicious apples, the double-faced fiberboard partitions were used in the control boxes and chipboard partitions, in the 50- by 30-cm. boxes. The dimensions of the cells in the experimental boxes were identical with those in the control boxes,

<sup>2</sup> Austria, Belgium, Canada, Denmark, the Federal Republic of Germany, France, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

<sup>3</sup> Recommendations on the International Standardization of Packaging for Fruits and Vegetables, Organization for Economic Cooperation and Development, Document 85, 1967.

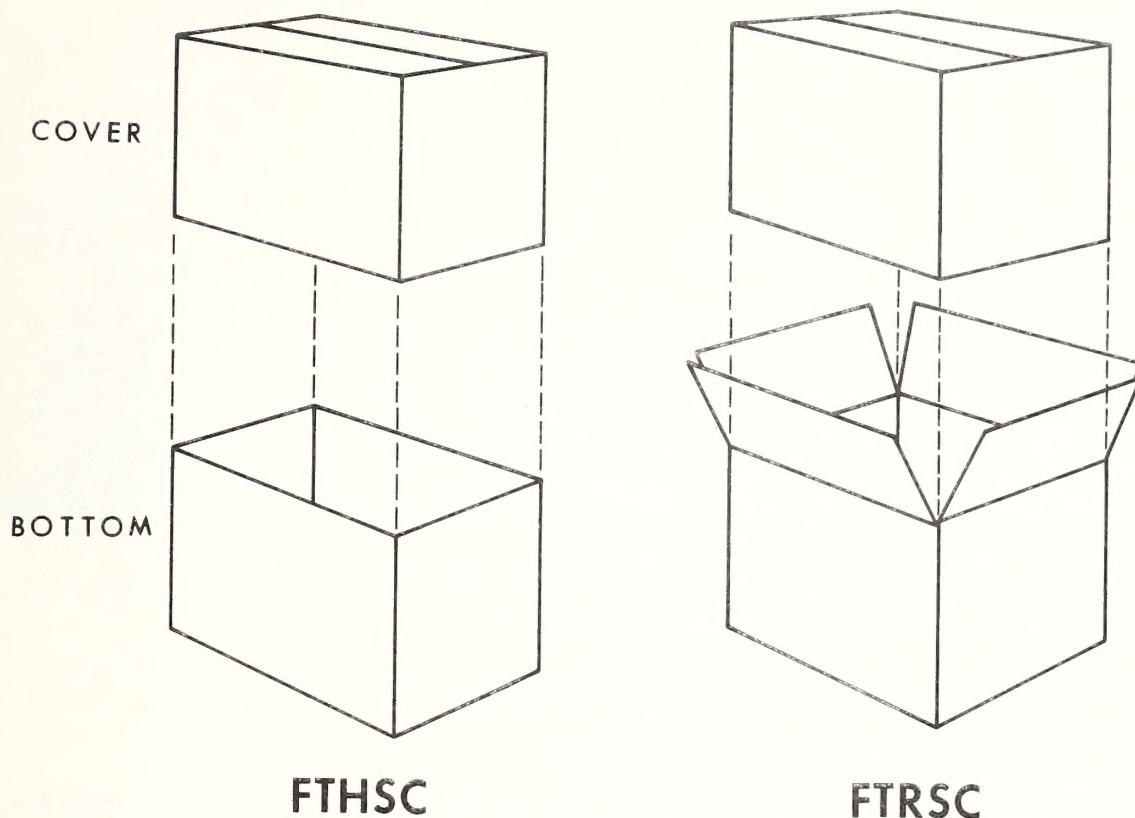


FIGURE 1.—Cell boxes used in test shipments from Maine and Washington to United Kingdom ports: *Left*, Full telescope half-slotted box (FTHSC); *right*, full telescope regular-slotted box (FTRSC). Cell dividers are not shown.

TABLE 1.—*Dimensions of 50- by 30-cm. and control cell boxes used for McIntosh apples in test shipments from Maine to New York City, November 1965–January 1966*

Box description <sup>1</sup> and count size of apples	Number of apples	Outside dimensions				Inside dimensions			Size of cells <sup>2</sup>		
		Length		Width		Length	Width	Depth	Length	Width	Depth
Experimental (FTHSC), 4-layer:		<i>Cm.</i>	<i>Inches</i>	<i>Cm.</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
200.....	160	50	19.7	30	11.8	19	11 $\frac{1}{8}$	10 $\frac{3}{4}$	2 $\frac{3}{8}$	2 $\frac{1}{16}$	2 $\frac{1}{2}$
160.....	140	50	19.7	30	11.8	19	11 $\frac{1}{8}$	11 $\frac{1}{2}$	2 $\frac{1}{2}$	2 $\frac{1}{4}$	2 $\frac{11}{16}$
140.....	128	50	19.7	30	11.8	19	11 $\frac{1}{8}$	12	2 $\frac{5}{8}$	2 $\frac{5}{16}$	2 $\frac{13}{16}$
Experimental (FTHSC), 3-layer:											
200.....	120	50	19.7	30	11.8	19	11 $\frac{1}{8}$	8 $\frac{1}{8}$	2 $\frac{3}{8}$	2 $\frac{1}{16}$	2 $\frac{1}{2}$
160.....	105	50	19.7	30	11.8	19	11 $\frac{1}{8}$	8 $\frac{11}{16}$	2 $\frac{1}{2}$	2 $\frac{1}{4}$	2 $\frac{11}{16}$
140.....	96	50	19.7	....	11.8	19	11 $\frac{1}{8}$	9 $\frac{1}{16}$	2 $\frac{5}{8}$	2 $\frac{5}{16}$	2 $\frac{13}{16}$
Control A (FTRSC):											
5-layer, 200.....	200	49.1	19.3	33.5	13.2	18 $\frac{5}{8}$	12 $\frac{1}{2}$	12 $\frac{1}{4}$	2 $\frac{3}{8}$	2 $\frac{1}{16}$	2 $\frac{3}{8}$
4-layer, 160.....	160	49.1	19.3	33.5	13.2	18 $\frac{5}{8}$	12 $\frac{1}{2}$	12 $\frac{1}{4}$	2 $\frac{1}{2}$	2 $\frac{1}{4}$	2 $\frac{13}{16}$
4-layer, 140.....	140	49.1	19.3	33.5	13.2	18 $\frac{5}{8}$	12 $\frac{1}{2}$	12 $\frac{1}{4}$	2 $\frac{5}{8}$	2 $\frac{5}{16}$	2 $\frac{13}{16}$
Control B (FTHSC):											
5-layer, 200.....	200	44.6	17.6	32.5	12.8	16 $\frac{7}{8}$	12 $\frac{1}{8}$	13 $\frac{1}{2}$	2 $\frac{3}{32}$	2 $\frac{13}{32}$	2 $\frac{1}{2}$
4-layer, 160.....	160	48.6	19.1	34.1	13.4	18 $\frac{1}{16}$	12 $\frac{3}{4}$	11 $\frac{3}{4}$	2 $\frac{5}{16}$	2 $\frac{9}{16}$	2 $\frac{11}{16}$
4-layer, 140.....	140	43.7	17.2	35.7	14.1	16 $\frac{1}{2}$	12 $\frac{3}{8}$	12 $\frac{3}{16}$	2 $\frac{23}{64}$	2 $\frac{43}{64}$	2 $\frac{13}{16}$

<sup>1</sup> (FTHSC), full telescope half-slotted box; (FTRSC), full telescope regular-slotted box.

<sup>2</sup> Size of cells in the 50- x 30-cm. boxes are the same as in control A box with exception of depths.

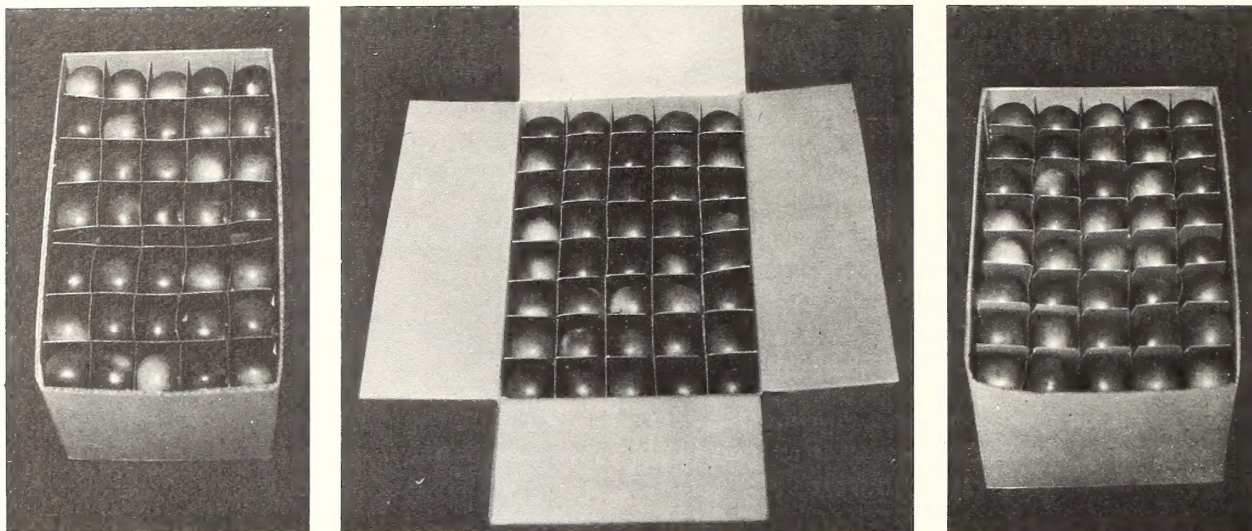


FIGURE 2.—Boxes used for McIntosh apples, count size 160, in test shipments from Maine to New York City, November 1965–January 1966: *Left*, 50- by 30-cm. (FTHSC) four-layer box holding 140 apples; *center*, control A (FTRSC) four-layer box holding 160 apples; and *right*, control B (FTHSC) four-layer box holding 160 apples. Note space dividers, or air cells, in the 50- by 30-cm. box.

with the unused space taken up with space dividers (figs. 2 and 3).

Paper tissue wraps and perforated polyethylene box liners were used for Golden Delicious apples. None were used for the McIntosh apples. This follows normal commercial practices.

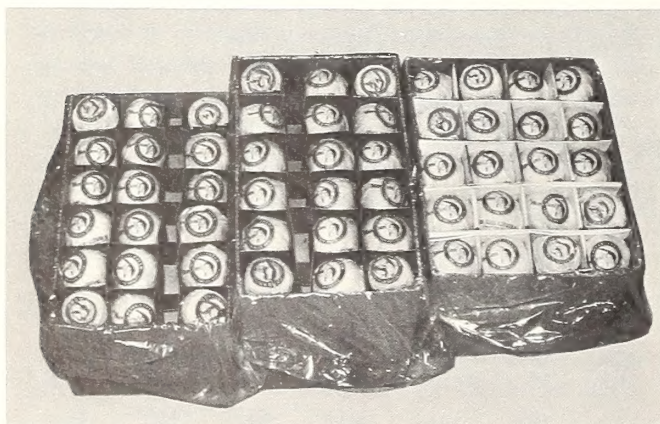


FIGURE 3.—Boxes used for Golden Delicious apples, count size 80, in test shipments from Washington to New York City, March–April 1966: *Left*, 50- by 30-cm. (FTHSC) three-layer box holding 54 apples; *center*, 50- by 30-cm. (FTHSC) four-layer box holding 72 apples; *right*, control C (FTHSC) four-layer box holding 80 apples. Note space dividers, or air cells, in 50- by 30-cm. boxes.

### Capacity

The net weight and density of pack for the 50- by 30-cm. boxes and control boxes of McIntosh apples are shown in table 3. The density—pounds of apples per cubic foot of volume—of the different size boxes varied from 18.7 to 20.7 pounds. Differences in density were also small among the different count sizes packed in each of the control and 50- by 30-cm. boxes. An average of 94.7 percent of the cubic capacity of the 50- by 30-cm. boxes was occupied by apples in cells as compared with 98.7 and 100 percent for control A and B boxes.

The net weight and the density of pack for the 50- by 30-cm. boxes and control C box of Golden Delicious apples are shown in table 4.

The density of pack for the 50- by 30-cm. boxes is less than that of the control boxes. In the 50- by 30-cm. boxes only 84.4 percent of the cubic capacity is occupied by cells containing apples as compared with 100 percent in the control boxes.

The various count sizes of Golden Delicious apples are commercially packed in boxes with different dimensions; that is, the boxes are constructed to fit the apples. It is impossible to make all different count-size apples fit a fixed

TABLE 2.—*Dimensions of 50- by 30-cm. and control cell boxes used for Golden Delicious apples in test shipments from Washington to New York City, March–April 1966*

Box description <sup>1</sup> and count size of apples	Number of apples	Outside dimensions				Inside dimensions			Size of cells <sup>2</sup>		
		Length		Width		Length	Width	Depth	Length	Width	Depth
Experimental (FTHSC), 4-layer:		<i>Cm.</i>	<i>Inches</i>	<i>Cm.</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>	<i>Inches</i>
140.....	112	50	19.7	30	11.8	19	11 $\frac{1}{8}$	11 $\frac{1}{8}$	2 $\frac{5}{8}$	2 $\frac{5}{8}$	2 $\frac{5}{8}$
120.....	96	50	19.7	30	11.8	19	11 $\frac{1}{8}$	11 $\frac{5}{8}$	2 $\frac{3}{4}$	2 $\frac{3}{4}$	2 $\frac{3}{4}$
96.....	72	50	19.7	30	11.8	19	11 $\frac{1}{8}$	12 $\frac{5}{8}$	3	3	3
80.....	72	50	19.7	30	11.8	19	11 $\frac{1}{8}$	13 $\frac{5}{8}$	3 $\frac{1}{4}$	3 $\frac{1}{4}$	3 $\frac{1}{4}$
80s.....	60	50	19.7	30	11.8	19	11 $\frac{1}{8}$	14 $\frac{1}{8}$	3 $\frac{7}{16}$	3 $\frac{7}{16}$	3 $\frac{3}{8}$
Experimental (FTHSC), 3-layer:											
140.....	84	50	19.7	30	11.8	19	11 $\frac{1}{8}$	8 $\frac{3}{8}$	2 $\frac{5}{8}$	2 $\frac{5}{8}$	2 $\frac{5}{8}$
120.....	72	50	19.7	30	11.8	19	11 $\frac{1}{8}$	8 $\frac{3}{4}$	2 $\frac{3}{4}$	2 $\frac{3}{4}$	2 $\frac{3}{4}$
96.....	54	50	19.7	30	11.8	19	11 $\frac{1}{8}$	9 $\frac{1}{2}$	3	3	3
80.....	54	50	19.7	30	11.8	19	11 $\frac{1}{8}$	10 $\frac{1}{4}$	3 $\frac{1}{4}$	3 $\frac{1}{4}$	3 $\frac{1}{4}$
80s.....	45	50	19.7	30	11.8	19	11 $\frac{1}{8}$	10 $\frac{5}{8}$	3 $\frac{7}{16}$	3 $\frac{7}{16}$	3 $\frac{3}{8}$
Control (FTHSC), 4-layer:											
140.....	140	51.4	20.2	35.9	14.1	19 $\frac{9}{16}$	13 $\frac{7}{8}$	11 $\frac{1}{8}$	2 $\frac{5}{8}$	2 $\frac{5}{8}$	2 $\frac{5}{8}$
120.....	120	46.2	18.2	38.6	15.2	17 $\frac{1}{2}$	14 $\frac{1}{2}$	11 $\frac{5}{8}$	2 $\frac{3}{4}$	2 $\frac{3}{4}$	2 $\frac{3}{4}$
96.....	96	50.0	19.7	33.8	13.3	19	12 $\frac{5}{8}$	12 $\frac{5}{8}$	3	3	3
80.....	80	45.1	17.7	36.3	14.3	17 $\frac{1}{16}$	13 $\frac{5}{8}$	13 $\frac{5}{8}$	3 $\frac{1}{4}$	3 $\frac{1}{4}$	3 $\frac{1}{4}$
80s.....	80	47.3	18.6	38.1	15.0	17 $\frac{5}{16}$	14 $\frac{5}{16}$	14 $\frac{1}{8}$	3 $\frac{7}{16}$	3 $\frac{7}{16}$	3 $\frac{3}{8}$

<sup>1</sup> (FTHSC), full telescope half-slotted box.<sup>2</sup> Size of cells in the 50- by 30-cm. boxes are the same as in the control boxes.<sup>3</sup> In each set of cell partitions, or layer, there were 3 cells measuring 2 $\frac{7}{8}$  x 3 $\frac{1}{4}$  x 3 $\frac{1}{4}$  inches. A small 80-count apple was placed in each of these cells, which made a total of 72 and 54, rather than 60 and 45, apples, respectively.TABLE 3.—*Gross and net weights, volume, density, and percent of capacity occupied in 50- by 30-cm. and control boxes packed with McIntosh apples, season 1965–66*

Box description and count size of apples	Number of apples	Weight <sup>1</sup>		Volume	Density <sup>2</sup>	Capacity occupied <sup>3</sup>
		Gross	Net			
50-by 30-cm. (FTHSC), 4-layer:		<i>Pounds</i>	<i>Pounds</i>	<i>Cu. ft.</i>	<i>Pounds</i>	<i>Percent</i>
200.....	160	34.9	30.7	1.54	19.9	94.8
160.....	140	37.1	32.8	1.64	20.0	93.8
140.....	128	38.6	34.1	1.71	20.0	95.4
Average.....	...	36.9	32.5	1.63	20.0	94.7
50-by 30-cm. (FTHSC), 3-layer:						
200.....	120	26.1	22.8	1.19	19.1	94.8
160.....	105	27.5	24.0	1.26	19.0	93.8
140.....	96	29.3	25.8	1.31	19.4	95.4
Average.....	...	27.6	24.2	1.25	19.2	94.7
Control A (FTRSC):						
5-layer, 200.....	200	42.0	36.5	1.98	18.4	96.0
4-layer, 160.....	160	41.9	36.8	1.98	18.6	100.0
4-layer, 140.....	140	43.2	37.9	1.98	19.1	100.0
Average.....	...	42.4	37.1	1.98	18.7	98.7
Control B (FTHSC):						
5-layer, 200.....	200	42.1	37.6	1.84	20.4	100.0
4-layer, 160.....	160	42.8	38.4	1.85	20.7	100.0
4-layer, 140.....	140	41.9	37.6	1.80	20.9	100.0
Average.....	...	42.3	37.9	1.83	20.7	100.0

<sup>1</sup> Difference between gross and net weight is tare weight of box, cell partitions, and pads.<sup>2</sup> Pounds of apples per cubic foot of box volume (outside dimensions).<sup>3</sup> Percent of box capacity (inside dimensions) occupied by usable cells.

TABLE 4.—*Gross and net weights, volume, density, and percent of capacity occupied in 50- by 30-cm. and control boxes packed with Golden Delicious apples, season 1965-66*

Box description and count size of apples	Number of apples	Weight <sup>1</sup>		Volume	Density <sup>2</sup>	Capacity occupied <sup>3</sup>
		Gross	Net			
50-by 30-cm. (FTHSC), 4-layer:		<i>Pounds</i>	<i>Pounds</i>	<i>Cu. ft.</i>	<i>Pounds</i>	<i>Percent</i>
140.....	112	38.4	33.4	1.59	21.0	91.8
120.....	96	38.5	33.4	1.66	20.1	89.5
96.....	72	35.9	30.8	1.79	17.2	77.0
80.....	472	41.4	36.1	1.92	18.8	79.3
80s.....	45	42.2	37.0	1.99	18.6	84.2
Average.....	...	39.3	34.1	1.79	19.1	84.4
50-by 30-cm. (FTHSC), 3-layer:						
140.....	84	29.4	25.4	1.22	20.8	91.8
120.....	72	29.3	25.2	1.27	19.8	89.5
96.....	54	27.1	23.0	1.37	16.8	77.0
80.....	454	31.6	27.4	1.47	18.6	79.3
80s.....	45	31.3	27.2	1.52	17.8	84.2
Average.....	...	29.7	25.6	1.37	18.8	84.4
Control C (FTHSC), 4-layer:						
140.....	140	49.1	43.6	1.95	22.4	100.0
120.....	120	47.3	41.8	1.97	21.2	100.0
96.....	96	48.3	43.1	2.02	21.3	100.0
80.....	80	47.1	41.7	2.10	20.0	100.0
80s.....	80s	55.2	49.4	2.39	20.7	100.0
Average.....	...	49.4	43.9	2.09	21.1	100.0

<sup>1</sup> Difference between gross and net weight is tare weight of box, cell partitions, pads, box liners, and tissue wraps.

<sup>2</sup> Pounds of apples per cubic foot of box volume (outside dimensions).

<sup>3</sup> Percent of box capacity (inside dimensions) occupied by usable cells.

<sup>4</sup> In each set of cell partitions, or layer, there were 3 cells measuring  $2\frac{7}{8} \times 3\frac{1}{4} \times 3\frac{1}{4}$  inches. A small 80-count apple was placed in each of these cells, which made a total of 72 and 54, rather than 60 and 45, apples, respectively.

size of box with fixed sizes of cells without some loss of space. The 50- by 30-cm. box is smaller than the control box. Larger apples do not fit in the smaller box so well as smaller apples.

Space dividers were used to form air cells to use the space not occupied by apples. An average of 15.6 percent of the cubic capacity of the 50- by 30-cm. boxes for Golden Delicious apples was occupied by air cells.

## Procedure

Five test truck shipments of McIntosh and five test rail shipments of Golden Delicious apples were made from Maine and Washington, respectively, to New York City to test the 50- by 30-cm. boxes in comparison with the control boxes. The 50- by 30-cm. boxes had the same size cells, in length and width, as control A and C boxes. It was believed U. S. apple shippers would not want to change their apple-sizing practices.

Arrangements were made with a packer in Maine and a packer in Washington to use their personnel and warehouse facilities for packing McIntosh and Golden Delicious varieties of apples in the boxes selected for the five shipping tests from each of these producing areas. The apples were inspected for maturity, bruising, and discoloration; only apples of uniform maturity and free of injury were packed in the boxes used for the five test shipments of each variety.

Time studies were made during the packing of each lot, and labor costs were calculated for the packing of each lot. Labor costs were calculated for the packing of each count size and variety in each size of box.

Costs of the boxes and pads were calculated, based on the square feet of fiberboard used in the construction of each box. Material costs are 1965-66 prices in quantities of 12,500 boxes.

Prevailing truck and railroad freight rates were used to determine the transport charges from Maine and Washington to New York City. Ocean freight charges were based on the rate in effect during the study. Also, theoretical ocean freight charges were computed on the basis of the actual displacement of the different size boxes, assuming that eventually the rate would be adjusted to reflect the space occupied by the boxes.

The McIntosh apples were stored in bulk bins at 32° F. from the time they were harvested until they were removed for sorting and packing in the boxes. Three count sizes of apples were selected: 200, 160, and 140, with dimensions of  $2\frac{3}{8}$ ,  $2\frac{1}{2}$ , and  $2\frac{5}{8}$  inches in diameter, respectively. Maturity readings were taken with a Magness-Taylor pressure tester.<sup>4</sup> The apples averaged 15.1-pound test (firm). Labor costs were calculated on the basis of \$1.25 per hour.

The Golden Delicious apples selected for the tests were packed in conventional cell boxes early in the season and held in cold storage at 28° F. In March 1966, the apples were unpacked and the bruised and damaged apples removed from the lot. Five sizes of apples were selected; namely, 140, 120, 96, 80, and 80 Super (s), with dimensions of  $2\frac{5}{8}$ ,  $2\frac{3}{4}$ , 3,  $3\frac{1}{4}$ , and  $3\frac{7}{16}$  inches, respectively. The reading taken with the Magness-Taylor pressure tester averaged 10.5 pounds (ripe). The bruise-free apples were packed in the test boxes and placed in cold storage (28° F.) until shipped at weekly intervals during March and April 1966 to New York, N.Y. Labor costs were calculated on a basis of \$1.60 per hour.

An experimental design was developed to de-

termine the placement of boxes within the load for use in statistically analyzing the bruising data. Individual boxes were labeled and placed in each shipment in a prescribed randomized manner according to the experimental design, with a different design for each shipment. At the completion of the five test shipments for each variety, each size of box had been transported in each representative position of the load.

Each of the five truck shipments of McIntosh apples included thirty 50- by 30-cm., 30 control A boxes, and 30 control B boxes. The 90 test boxes were loaded near the rear of the trailer body so that bruising would reflect maximum rough handling during transit. Typical loading patterns used for the truck shipments are illustrated in figure 4.

Each of five rail shipments of Golden Delicious apples included fifty 50- by 30-cm. boxes and 50 control boxes. Because of the differences in dimensions of the 50- by 30-cm. and control boxes and because of railroad container and loading rules, it was necessary to load the 50- by 30-cm. boxes in one stack (near the doorway) in a randomized manner. Control boxes were placed in the stacks containing the experimental boxes. Typical loading patterns used for the rail shipments are illustrated in figure 5.

Each box was inspected for damage as it was unloaded from the truck at the wholesale warehouse or from the refrigerator car at the railroad piers.

Thirty-six boxes (2 boxes for each size of apple and for each size of box) from each truck shipment of McIntosh apples and 40 boxes from each rail shipment of Golden Delicious apples were selected and taken to New Brunswick, N.J., for inspection of bruising of the apples—the remaining 54 boxes of McIntosh apples and the remaining 60 boxes of Golden Delicious apples were sold. Each box was weighed, then unpacked, and each individual apple was inspected and scored for degree of bruising, as follows:

<i>Extent of bruising</i>	<i>Size of damage area</i>
Slight .....	$\frac{1}{4}$ to $\frac{3}{4}$ inch in diameter
Damage .....	$\frac{3}{4}$ to 1 inch in diameter
Serious damage ..	Over 1 inch in diameter

<sup>4</sup> HALLER, M. H. 1941. FRUIT PRESSURE TESTERS AND THEIR PRACTICAL APPLICATIONS. U.S. Dept. Agr. Cir. 627, 21 pp.

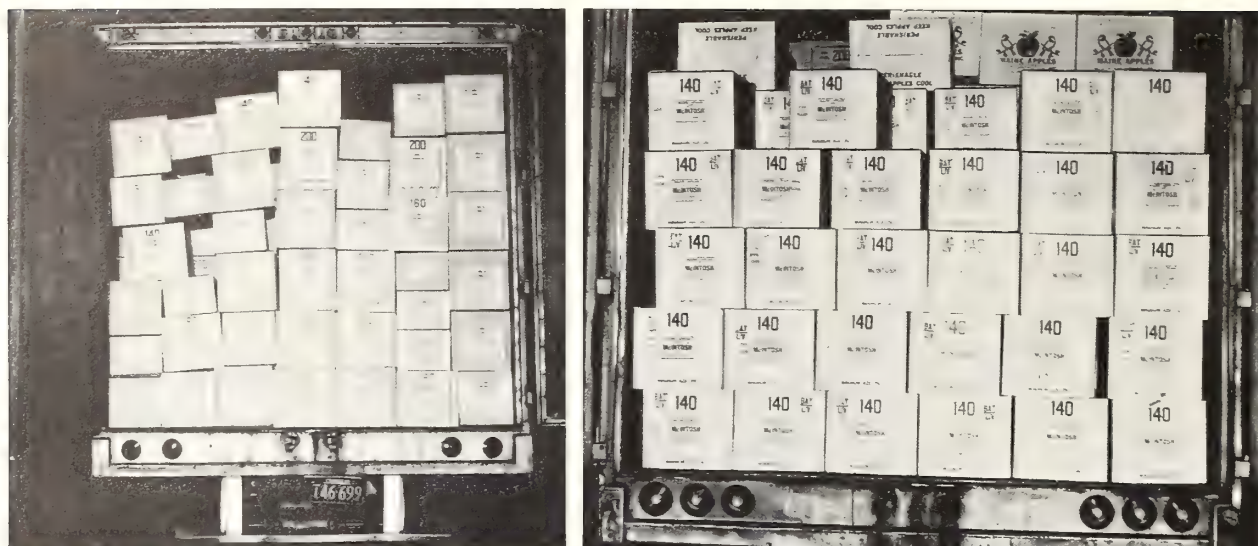


FIGURE 4.—Views of typical loading patterns for truck shipments of McIntosh apples from Maine to New York City, November 1965–January 1966: *Left*, 50- by 30-cm. boxes; and *right*, control boxes.

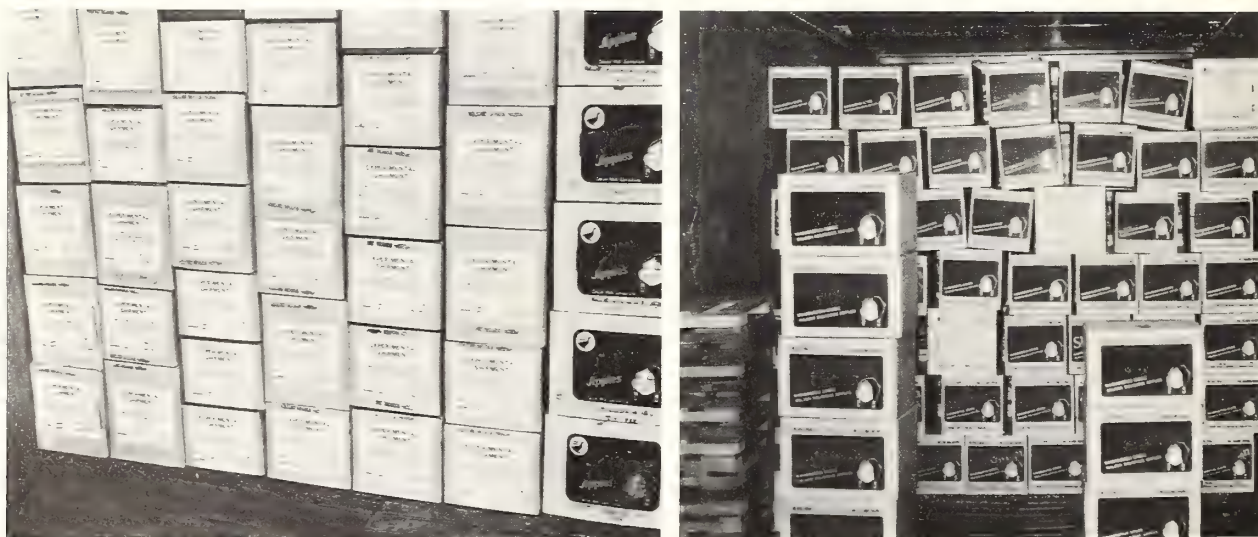


FIGURE 5.—Views of typical loading patterns for rail shipments of Golden Delicious apples from Wenatchee, Wash. to New York City, March–April 1966: *Left*, 50- by 30-cm. boxes; *right*, control boxes.

In addition, each apple was inspected for skin discoloration, stem puncture, cuts, skin breaks, and decay. The empty box, including pads, cell

dividers, liners, and paper tissue, was weighed and then repacked with apples. The apples were then sold.

## Bruising of Apples and Condition of Boxes

### Bruising of Apples

Bruising was nearly the same for the McIntosh and Golden Delicious apples packed in the 50- by 30-cm. boxes as in the control boxes (tables 5 and 6). For each variety of apples the differences in the amount of bruising, by degree of bruise, were not statistically significant.

### Condition of Boxes

All boxes arrived in excellent condition; no damage was observed in any of the five truck shipments of McIntosh apples and five rail shipments of Golden Delicious apples. Less than 2 percent of the labels on the boxes packed with Golden Delicious apples were defaced in varying degrees.

TABLE 5.—*Percentage of McIntosh apples bruised in 50-by 30-cm. and control boxes during transit, by degree of bruising, in 5 truck shipments from Maine to New York City, November 1965–January 1966*

Box description and count size of apples	Number of apples	Degree of bruising <sup>1</sup>			
		Slight	Damage	Serious damage	Total
50- by 30-cm. (FTHSC), 4-layer†					
200.....	160	7.6	0.8	0.2	8.6
160.....	140	4.3	.5	.0	4.8
140.....	128	8.3	2.0	.1	10.4
Average.....	...	6.7	1.1	.1	7.9
Control A (FTRSC):					
5-layer, 200.....	200	4.4	.5	.1	5.0
4-layer, 160.....	160	3.3	1.0	.1	4.4
4-layer, 140.....	140	6.8	.8	.0	7.6
Average.....	...	4.8	.8	.1	5.7
Control B (FTHSC):					
5-layer, 200.....	200	2.1	.4	.2	2.7
4-layer, 160.....	160	4.3	1.5	.2	6.0
4-layer, 140.....	140	7.8	1.5	.4	9.7
Average.....	...	4.7	1.1	.3	6.1

<sup>1</sup> Differences in bruising between boxes were not statistically significant at the 5-percent level. Skin discoloration, skin breaks, and cuts were negligible.

TABLE 6.—*Percentage of Golden Delicious apples bruised in 50- by 30-cm. and control boxes during transit, by degrees of bruising, in 5 rail shipments from Wenatchee, Wash., to New York City, March–April 1966*

Box description and count size of apples	Number of apples	Degree of bruising <sup>1</sup>			
		Slight	Damage	Serious damage	Total

50- by 30-cm. (FTHSC), 4-layer:					
140.....	112	13.0	2.0	0.0	15.0
120.....	96	22.3	3.4	.3	26.0
96.....	72	28.9	2.5	.4	31.8
80.....	272	33.6	4.0	.3	37.9
80s.....	60	27.7	5.5	1.3	34.5
Average.....	...	25.1	3.5	.4	29.0

Control C (FTHSC), 4-layer:					
140.....	140	14.5	2.1	.5	17.1
120.....	120	18.3	3.6	.9	22.8
96.....	96	34.9	4.4	.9	40.2
80.....	80	33.2	2.7	1.1	37.0
80s.....	80s	25.3	7.1	4.5	36.9
Average.....	...	25.2	4.0	1.6	30.8

<sup>1</sup> Differences in bruising between boxes were not statistically significant at the 5- or 1-percent levels. Skin discoloration, skin breaks, and cuts were negligible.

<sup>2</sup> In each set of cell partitions, or layer, there were 3 cells measuring  $2\frac{7}{8} \times 3\frac{1}{4} \times 3\frac{1}{4}$  inches. A small 80-count apple was placed in each of these cells, which made a total of 72, rather than 60, apples.

## Costs and Charges

### Packaging Materials and Labor Costs

Costs of packaging materials, including box, cell partitions, and pads, and labor for assembly, packing, and handling the boxes of McIntosh apples are shown in table 7. The cost of \$2.15 for packing 100 pounds of apples in the 50- by 30-cm. boxes was midway between cost of \$2.01 for packing the control B (FTHSC) box and \$2.24 for the more expensive control A (FTRSC) box. The 50- by 30-cm. box costs more per 100 pounds of apples to pack than the control B box because fewer apples can be packed in it. But the 50- by 30-cm. box costs less than the control A box.

The difference of 23 cents per 100 pounds of McIntosh apples packed in control A box and in control B box is because of differences in size and construction (see fig. 1) of the boxes. More square feet of corrugated fiberboard are required for the larger size full telescope regu-

lar-slotted box (control A) than for the full telescope half-slotted box (control B).

Costs of the packaging materials and labor for packing Golden Delicious apples were about the same for the 50- by 30-cm. box as for the control box (\$2.25 and \$2.23 per 100 pounds, respectively) (table 8). This is because the chipboard cell dividers in the 50- by 30-cm. boxes cost less than the corrugated fiberboard cell dividers used in the control boxes.

### Storage Costs

McIntosh apples are not packed into the export shipping container until they are ready to be shipped. Therefore the use of a box of low density would have little effect on storage costs. Packers of Washington Golden Delicious apples, however, pack them into the shipping containers during the fall, because they bruise less easily than they do after several months' storage. Also they are less likely to shrivel

TABLE 7.—*Cost of packaging materials and labor for assembling boxes, packing, and handling McIntosh apples in 50- by 30-cm. and control boxes, Monmouth, Maine, November 1965–January 1966*

Box description and count size of apples	Number of apples	Cost per box					Cost per 100 pounds of apples
		Packag- ing <sup>1</sup> materials	Box assembly <sup>2</sup>	Packing apples <sup>3</sup>	Handling boxes <sup>4</sup>	Total	
50- by 30-cm. (FTHSC), 4-layer:							
200.....	160	<i>Dollars</i> 0.5757	<i>Dollars</i> 0.0062	<i>Dollars</i> 0.0965	<i>Dollars</i> 0.0078	<i>Dollars</i> 0.6862	<i>Dollars</i> 2.24
160.....	140	.5945	.0062	.0955	.0078	.7040	2.15
140.....	128	.6020	.0062	.0868	.0078	.7028	2.06
Average.....	...	.5907	.0062	.0929	.0078	.6976	2.15
Control A (FTRSC):							
5-layer, 200 .....	200	.7362	.0062	.1437	.0080	.8941	2.45
4-layer, 160 .....	160	.6684	.0062	.1073	.0080	.7899	2.15
4-layer, 140 .....	140	.6844	.0062	.1035	.0080	.8021	2.12
Average.....	...	.6963	.0062	.1182	.0080	.8287	2.24
Control B (FTHSC):							
5-layer, 200 .....	200	.6328	.0062	.1243	.0080	.7713	2.03
4-layer, 160 .....	160	.6454	.0062	.1028	.0080	.7624	2.01
4-layer, 140 .....	140	.6471	.0062	.0941	.0080	.7554	1.99
Average.....	...	.6418	.0062	.1071	.0080	.7631	2.01

<sup>1</sup> Includes cost of boxes, cell partitions, and pads.

<sup>2</sup> Labor costs required to staple boxes, based on hourly wage of \$1.50.

<sup>3</sup> Labor costs required to procure box and materials and fully pack the box, based on hourly wage of \$1.25.

<sup>4</sup> Labor costs required to handle each box twice in packinghouse, based on hourly wage of \$1.50.

(dehydrate) if they are packed into shipping boxes with polyethylene liners than if they are stored in bulk bin boxes.

For the Golden Delicious apples, the reduced efficiency in the use of space in the 50- by 30-cm. boxes as compared with the control C boxes (19.1 pounds per cu. ft. vs. 21.1 pounds) is offset by the increased efficiency in use of space on the pallets on which the apples are stored. The 50- by 30-cm. boxes fit 48- by 40-in. pallets eight to a layer versus six or seven boxes per layer for control C boxes.

### Transport Charges

The ocean freight rate in 1966 for shipping apples from eastern ports to Europe was \$0.95 per box not exceeding 2 cubic feet 2 cubic inches of displacement. The 50- by 30-cm. boxes and types A, B, and most sizes of type C control boxes used in this study are less than 2 cubic feet 2 cubic inches (2.002 cubic feet); therefore, the rate for each was \$0.95 per box.

It is assumed that ocean freight rates will ultimately reflect significant changes in displacement of shipping containers. Therefore, theoretical ocean transport charges were calculated on the basis of the actual displacement of the boxes.

Transport charges, per 100 pounds of apples, for shipping McIntosh apples to United Kingdom ports by truck and ship would be \$3.38 in the 50- by 30-cm. boxes compared with \$3.54 in control A (FTRSC) boxes and \$3.27 in control B (FTHSC) boxes (table 9).

Corresponding rail and ocean transport charges for shipping Golden Delicious apples to United Kingdom ports in the 50- by 30-cm. and control boxes would be \$5.21 and \$4.91, respectively, for 100 pounds of fruit (table 10).

The importance of high-density packs to obtain lower ocean freight charges per pound of apples shipped is shown by the relation of the density of pack to the freight charges. This relation is shown in the following tabulation:

TABLE 8.—*Cost of packaging materials and labor for assembling boxes, packing, and handling Golden Delicious apples in 50- by 30-cm. and control boxes, Wenatchee, Wash., March–April 1966*

Box description and count size of apples	Number of apples	Cost per box					Cost per 100 pounds of apples
		Packag- ing <sup>1</sup> materials	Box assembly <sup>2</sup>	Packing apples <sup>3</sup>	Handling boxes <sup>4</sup>	Total	
50- by 30-cm. (FTHSC), 4-layer:		<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
140.....	112	0.6148	0.0062	0.1560	0.0078	0.7848	2.35
120.....	96	.6181	.0062	.1267	.0078	.7588	2.27
96.....	72	.6249	.0062	.1155	.0078	.7544	2.45
80.....	<sup>5</sup> 72	.6403	.0062	.1093	.0078	.7636	2.12
80s.....	60s	.6540	.0062	.0923	.0078	.7603	2.05
Average.....	...	.6304	.0062	.1200	.0078	.7644	2.25
Control C (FTHSC):							
140.....	140	.8570	.0062	.1938	.0080	1.0650	2.44
120.....	120	.7841	.0062	.1631	.0080	.9614	2.30
96.....	96	.7410	.0062	.1453	.0080	.9005	2.09
80.....	80	.8106	.0062	.1289	.0080	.9537	2.29
80s.....	80s	.8706	.0062	.1280	.0080	1.0128	2.05
Average.....	...	.8127	.0062	.1518	.0080	.9787	2.23

<sup>1</sup> Includes cost of boxes, cell partitions, pads, polyethylene liners, and tissue wraps.

<sup>2</sup> Labor costs required to staple boxes, based on hourly wage of \$1.50.

<sup>3</sup> Labor costs required to procure box and materials and fully pack the box, based on hourly wage of \$1.60.

<sup>4</sup> Labor costs required to handle each box twice in packinghouse, based on hourly wage of \$1.50.

<sup>5</sup> In each set of cell partitions, or layer, there were 3 cells measuring  $2\frac{7}{8} \times 3\frac{1}{4} \times 3\frac{1}{4}$  inches. A small 80-count apple was placed in each of these cells, which made a total of 72, rather than 60, apples.

For McIntosh apples:	<i>Density</i>	<i>Cost</i>
Control A .....	18.7	\$3.54
50- by 30-cm.....	20.0	3.38
Control B .....	20.7	3.27
For Golden Delicious apples:		
50- by 30-cm.....	19.1	\$5.21
Control C .....	21.1	4.91

costs and charges per equivalent box holding 38 pounds would be \$2.10, \$2.20, and \$2.01. On the basis of a rate of \$0.95 per box of 2 cubic feet 2 cubic inches or less, these costs and charges would be \$2.31 for the 50- by 30-cm. box, \$2.20 for the control A box, and \$2.09 for the control B box.

On the basis of actual displacement of each box, the total costs and charges per 100 pounds of Golden Delicious apples would be \$7.46 and \$7.14 for the 50- by 30-cm. and the control C box, respectively. These costs and charges per equivalent box holding 44 pounds of apples would be \$3.28 and \$3.14. But if the smaller 50- by 30-cm. box is required to bear the present rate of \$0.95 per box of 2 cubic feet 2 cubic inches or less, the total costs and charges per box would be \$3.41, or about \$0.27 more per box than the control box.

### Total Costs and Charges

The total for the packaging materials and labor costs and transport charges is shown in table 11.

On the basis of actual displacement of each box, the total costs and charges (those affected by type and size of shipping container) from Maine to United Kingdom ports per 100 pounds of McIntosh apples would be \$5.53, \$5.78, and \$5.28 for the 50- by 30-cm., the control A, and the control B box, respectively. These

TABLE 9.—*Transport charges for shipping McIntosh apples from Maine to United Kingdom ports, season 1965-66*

Box description and count size of apples	Displacement	Truck freight charges from Maine to New York <sup>1</sup>		Ocean freight charges from New York to United Kingdom ports <sup>2</sup>		Total transport charge per 100 pounds fruit
		Per box	Per 100 pounds of fruit	Per box	Per 100 pounds of fruit	
50-by 30-cm. (FTHSC), 4-layer:	<i>Cu. ft.</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
200.....	1.54	0.307	1.00	0.732	2.38	3.38
160.....	1.64	.327	1.00	.779	2.38	3.38
140.....	1.71	.340	1.00	.812	2.38	3.38
Average.....	1.63	.325	1.00	.774	2.38	3.38
Control A (FTRSC):						
5-layer, 200.....	1.98	.370	1.01	.941	2.58	3.59
4-layer, 160.....	1.98	.369	1.00	.941	2.56	3.56
4-layer, 140.....	1.98	.380	1.00	.941	2.48	3.48
Average.....	1.98	.373	1.00	.941	2.54	3.54
Control B (FTHSC):						
5-layer, 200.....	1.84	.371	.98	.874	2.32	3.30
4-layer, 160.....	1.85	.376	.99	.879	2.29	3.28
4-layer, 140.....	1.80	.369	.97	.855	2.27	3.24
Average.....	1.83	.372	.98	.869	2.29	3.27

<sup>1</sup> Based on a cost of \$0.88 per hundredweight. See *Cost of Transporting Freight by Class I and Class II Motor Common Carriers of General Commodities, New England Region-1962, Group II-Between New England and New York City Area and Beyond*, Statement No. 8-63, Cost Finding Section, Bureau of Accounts, Interstate Commerce Commission, Washington, D.C., December 1963.

<sup>2</sup> Charges based on actual displacement of each box at \$0.95 per 2 cubic feet 2 cubic inches of displacement.

### Three-Layer 50- by 30-Cm. Boxes

Europeans frequently complain that the boxes of apples exported from the United States weighing 40 to 45 pounds are too large for a number of reasons—retail store stocks and consumers' purchases of apples are smaller than in the United States, and women that are employed in retail stores do not like to handle more than about 15 k., or 33 pounds, of fruit. Trade sources estimate that during 1968 about half of the apples grown in the United Kingdom were marketed in the smaller, or "three-fourths," size boxes.

A three-layer 50- by 30-cm. box was tested in this study to obtain costs of packing and transporting apples packed in a box holding 33 pounds or less. The average gross weight of the

different count sizes of apples packed in the three-layer boxes was 27.6 pounds for McIntosh apples and 29.7 pounds for Golden Delicious apples.

On the basis of actual displacement of each box, the use of the three-layer cell box would increase the average cost of packing and transporting apples to United Kingdom ports by \$0.24 and \$0.22 per hundredweight for McIntosh and Golden Delicious apples, respectively, over the cost to pack and ship them in four-layer 50- by 30-cm. boxes (table 12). This is the equivalent to \$0.09 and \$0.10 more per 38 and 44 pounds of McIntosh and Golden Delicious apples. On the basis of 1966 ocean freight rates of \$0.95 per box of 2 cubic feet 2 cubic inch or

TABLE 10.—*Transport charges for shipping Golden Delicious apples from Washington to United Kingdom ports, season 1965-66*

Box description and count size of apples	Displacement	Rail freight charges from Washington to New York <sup>1</sup>		Ocean freight charges from New York to United Kingdom ports <sup>2</sup>		Total transport charge per 100 pounds fruit
		Per box	Per 100 pounds of fruit	Per box	Per 100 pounds of fruit	
50- by 30-cm. (FTHSC), 4-layer:	<i>Cu. ft.</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
140.....	1.59	0.906	2.71	0.755	2.26	4.97
120.....	1.66	.909	2.72	.789	2.36	5.08
96.....	1.79	.847	2.75	.850	2.76	5.51
80.....	1.92	.976	2.70	.912	2.52	5.23
80s.....	1.99	.996	2.69	.945	2.55	5.24
Average.....	1.79	.927	2.72	.850	2.49	5.21
Control C (FTHSC), 4-layer:						
140.....	1.95	1.158	2.66	.926	2.13	4.79
120.....	1.97	1.115	2.67	.936	2.23	4.90
96.....	2.02	1.139	2.64	.960	2.23	4.87
80.....	2.10	1.112	2.67	.993	2.38	5.05
80s.....	2.39	1.302	2.64	1.135	2.30	4.93
Average.....	2.09	1.165	2.66	.990	2.25	4.91

<sup>1</sup> Based on a cost of \$2.36 per hundredweight, which includes \$2.27 for rail transportation from the Wenatchee Valley to New York City and a wharfage charge of \$0.09 per hundredweight.

<sup>2</sup> Charges based on actual displacement of each box at \$0.95 per 2 cubic feet 2 cubic inches of displacement.

less, the costs would be equivalent to \$0.45 more per 38 pounds of McIntosh apples and \$0.48 more for 44 pounds of Golden Delicious apples.

The three-layer boxes of McIntosh and Golden Delicious apples were shipped from Maine and Washington to New York City in the same

shipments used to test the four-layer 50- by 30-cm. boxes. No significant differences in bruising, by degree of bruising, were found between the three-layer and four-layer 50- by 30-cm. boxes or between the three-layer and control boxes.

### Discussion and Conclusions

The dimensions of most cell-type boxes used in the United States are made to conform to the space required by the various count sizes of apples. If all the various count sizes of apples are packed into one size of box, some space will be wasted for certain count sizes of apples. It was assumed in this study that, at least for the present, United States exporters of apples would not want to change their established apple-sizing practices. If different sized apples or if more than one size of apples were to be cell-packed into one given size box, such as the 50- by 30-cm. box, it is conceivable that higher

density packs could be developed than were developed in this study.

The results of this study show that it would cost (at ocean freight rate of \$0.95 per box) \$0.11 to \$0.22 more per equivalent 38-pound box to ship McIntosh apples in a 50- by 30-cm. cell box than to ship them in the presently used two main types of boxes. If ocean freight rates were adjusted to reflect the actual displacement of the 50- by 30-cm. box, the cost for exporting McIntosh apples in the 50- by 30-cm. box would be \$0.10 less per box than in control A box and \$0.09 more than in control B box.

TABLE 11.—*Costs of packaging materials, packing and handling labor, and transport charges per 100 pounds and per box<sup>1</sup> of McIntosh and Golden Delicious apples packed in 50- by 30-cm. cell boxes and in control boxes from production areas to United Kingdom ports, season 1965-66*

Item	McIntosh			Golden Delicious	
	50 by 30 cm. (FTHSC)	Control A (FTRSC)	Control B (FTHSC)	50 by 30 cm. (FTHSC)	Control C (FTHSC)
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Packaging materials <sup>2</sup> .....	1.82	1.88	1.69	1.85	1.85
Labor.....	.33	.36	.32	.40	.38
Total.....	2.15	2.24	2.01	2.25	2.23
Transportation:					
Truck.....	1.00	1.00	.98	.....	.....
Rail.....	.....	.....	.....	2.72	2.66
Ocean <sup>3</sup> .....	2.38	2.54	2.29	2.49	2.25
Total.....	3.38	3.54	3.27	5.21	4.91
Total per 100 pounds.....	5.53	5.78	5.28	7.46	7.14
Total per box: <sup>4</sup>					
Theoretical ocean freight charges <sup>5</sup> .....	2.10	2.20	2.01	3.28	3.14
1966 ocean freight charges <sup>5</sup> .....	2.31	2.20	2.09	3.41	3.14

<sup>1</sup> Average of all count sizes packed for each type of box.

<sup>2</sup> Cost of box, cell partitions, and pads; includes tissue wraps and polyethylene liners for Golden Delicious.

<sup>3</sup> Charges based on actual displacement of each box at \$0.95 for each unit displacing 2 cubic feet 2 cubic inches.

<sup>4</sup> Packaging material and labor costs and truck and rail charges based on costs and charges given and a net weight of 38 pounds per box for McIntosh apples and 44 pounds for Golden Delicious apples; ocean freight charges calculated as indicated.

<sup>5</sup> Charges based on a cost of \$0.95 each for boxes not exceeding 2 cubic feet 2 cubic inches of displacement.

This study also shows that it would cost (at ocean freight rate of \$0.95 per box) about \$0.27 more per equivalent 44-pound box to ship Washington Golden Delicious apples in a 50- by 30-cm. box than to ship them in the presently used (control C) box. If ocean freight rates were adjusted to reflect the actual displacement of the 50- by 30-cm. box, the cost for shipping Washington Golden Delicious in the 50- by 30-cm. box would be \$0.14 more per box.

If the U.S. apple industry attempted to meet the demands of some European customers by exporting McIntosh and Golden Delicious apples in a three-layer 50- by 30-cm. box instead of a four-layer 50- by 30-cm. box, the cost would be \$0.45 more per equivalent box (38 pounds) for McIntosh apples and \$0.48 more per equivalent

box (44 pounds) for Washington Golden Delicious apples unless the freight rates were adjusted downward for the smaller size box. If the ocean freight rates were adjusted to reflect the cubic displacement of the three-layer box, the cost of packing and shipping McIntosh and Golden Delicious apples would be only \$0.09 and \$0.10 more per 38-pound and 44-pound box equivalent.

It is apparent from this study that it would cost more to export McIntosh and Golden Delicious apples in a proposed European standard size box of 50 by 30 cm. than in our presently used boxes. But, there would be some offsetting economies not evaluated in this study. For example, if more of our perishable products can be shipped, palletized or unitized in some way,

TABLE 12.—*Costs of packaging materials, packing and handling labor, and transport charges per 100 pounds and per equivalent box<sup>1</sup> of McIntosh and Golden Delicious apples packed in 3-layer and 4-layer boxes to the United Kingdom ports, season 1965-66*

Item	McIntosh apples		Golden Delicious apples	
	3-layer box	4-layer box	3-layer box	4-layer box
	<i>Dollars</i>	<i>Dollars</i>	<i>Density</i>	<i>Dollars</i>
Packaging materials <sup>2</sup> .....	1.97	1.82	1.97	1.85
Labor.....	.34	.33	.41	.39
Total.....	2.31	2.15	2.38	2.24
Transportation:				
Truck.....	1.01	1.00	.....	.....
Rail.....	.....	.....	2.74	2.71
Ocean <sup>3</sup> .....	2.45	2.38	2.54	2.49
Total per 100 pounds.....	5.77	5.53	7.66	7.44
Total per box: <sup>4</sup>				
Theoretical ocean freight charges <sup>3</sup> ..	2.19	2.10	3.37	3.27
1966 ocean freight charges <sup>5</sup> .....	2.76	2.31	3.89	3.41

<sup>1</sup> Average of all count sizes packed for each type of box.

<sup>2</sup> Cost of box, cell partitions, and pads; includes tissue wraps and polyethylene liners for Golden Delicious.

<sup>3</sup> Charges based on actual displacement of each box at \$0.95 for each unit displacing 2 cubic feet 2 cubic inches.

<sup>4</sup> Packaging material and labor costs and truck and rail charges based on costs and charges given and per 38-pound box equivalent for McIntosh apples and a 44-pound box equivalent for Golden Delicious apples; ocean freight charges calculated as indicated.

<sup>5</sup> Charges based on a cost of \$0.95 each for boxes not exceeding 2 cubic feet 2 cubic inches of displacement.

the use of one size of box, such as the 50- by 30-cm. box, would yield greater efficiency in use of space in storage and in transport vehicles. This advantage would be even greater as more products are packed and shipped in uniform-size containers, particularly when different products are mixed in wholesale stores and in delivery vehicles distributing produce to retail stores. This should result in increased efficiency in handling boxes and reduce product and container damage.

Also, from the apple shipper's point of view,

economies can be gained in costs of carrying inventories of packaging materials if fewer types and sizes of containers are used. Economies can also be gained in manufacturing containers and other packaging materials if they are comparable in size and shape.

Therefore, in the short run, it would appear disadvantageous for the U. S. apple industry to export apples in a 50- by 30-cm. box, but not necessarily in the long run, if uniform size boxes could be developed that would be acceptable to both foreign and domestic receivers.